IIEP seminar paper (41)

THE CONTRIBUTION OF EDUCATION TO INDUSTRIALIZATION AND TECHNICAL PROGRESS IN DEVELOPING COUNTRIES

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A contribution to the IIEP Workshop on:
"Educational and training system reforms contributing to industrial and technological development"
directed by R.M. Avakov,
27-29 October 1980

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FOR EDUCATIONAL PLANNING
(established by Unesco)
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INTRODUCTION

The aim of the present paper is to examine the relations between educational and training systems on the one hand, and industrialisation and technical progress on the other, especially in the developing countries. No one today would deny the close correlation that exists between these three phenomena. Our purpose here is to see how relations between them interact and develop, to examine difficulties and their repercussions, and to study how education contributes to industrial development and technical progress in the Third World.

This document has been prepared for the use of the Workshop[1] on "Educational and Training Systems Reforms Contributing to Industrial and Technological Development" and is intended to serve as an introduction to a discussion of the subject. It by no means claims to be exhaustive; indeed, it represents the very first draft of a study which we hope to pursue more fully and in greater depth in the light of the discussions and ideas thrown out by the Workshop.

Why is this topic relevant ?

The problem is not a new one. It has been on the agenda of development strategies for some time now. Its importance was once more confirmed by the recent international conferences held in Vienna (August 1979, United Nations Conference on Science and Technology for Development), and in New Delhi (January-February 1980, Third General Conference of UNIDO), as well as at the most recent sessions of Unesco's Executive Board.

At its 108th Session, the latter took note of the growing rôle of science and technology in development, and of the implications for education; it called for the strengthening of the scientific and technical capacities of developing countries, through the reinforcement of educational work in particular.

These countries are planning to embark on a task of great magnitude in order to give a major stimulus to their industrialization and to the creation of a national scientific and technical potential capable of tackling the fundamental problems of development. One example of

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[1] Held in Paris from 27 to 29 October 1980.

this would be the Lima goal of achieving 25 per cent of world manufactured output by the year 2000.

Achieving this objective would mean not merely a substantial increase in the industrial might of these countries but also a change in their industrial structure, and a scientific and technical transformation. It would entail a greater effort still in the field of education, a radical review of technical training programmes, and close articulation of educational planning and scientific and technological policies. Without this kind of effort on the educational side, this process of industrialisation based on national scientific and technical progress would surely lead to a build-up of dead, sterile capital in the developing countries.

It is with these questions in mind that the International Institute for Educational Planning has undertaken this study and organised the above mentioned Workshop.

It is our contention that the proposed theme calls for action on an international scale, for joint action by international and national organisations, and for the involvement of people representing different fields of research and sectors of productive activity. For this topic lies at the very heart of current concerns and development prospects for the coming decades. The IIEP's ambitions are very modest. It has been necessary to limit the scope of the project, hence to select a small number of problems to be resolved.

The first need was to decide where to lay the main emphasis. This will in fact fall on that part of educational and training systems whose purpose is directly to serve industrialisation and technological progress. This involves the education and training of industrial manpower at all levels. Next, it was decided to confine the study to those developing countries alone that have some relatively significant experience of development in all three areas : industry, education/training, and the scientific and technical sector. Lastly, the study is based partly on normative documents (planning and policy documents in each of the three areas cited), and partly on reforms (or major decisions, programmes, etc.) undertaken in these developing countries with a view to improving industrial and scientifico-technical change, which have produced positive results or regional, national and international interest.

CHAPTER I. CONCEPTUAL FRAMEWORK

In this Chapter, we have tried to define the conceptual framework of the study. The focal point is an analysis of the historical conditions of development in the Third World, which determine the specific characteristics, and which condition the complexity of their struggle and of their efforts to throw off the heavy burden of under-development.

In addition, we have sought to give definitions of some of the notions employed, and to give a brief account of existing approaches to the interpretation of the place of education in manpower training, and of proposed solutions.

(a) The problem

The end of the 1970s marks the close of an important period, and the starting point of a new phase in the evolution of development strategies, especially those designed to achieve scientifico-technical and educational progress.

It would be a mistake to deny the positive results and significant successes obtained by developing countries in the way of economic and scientifico-technical progress in the period under discussion, both in the establishment and the strengthening of national educational and training systems. So, we ought not to underestimate the rôle of planning and its merits. On the other hand, though, negative tendencies due to several different factors have also been observed in the development of the national systems.

In the developing countries, the period just completed stressed the quantitative aspects of development in particular : economic growth, efforts to increase national income, rapid expansion of education, scientific policy centred upon the transfer of imported technologies, and open-door policy to foreign investment, a certain tendency in favour of a redistribution of industrial capacities and structures.

A new situation thus arose, creating new problems which could not be handled with the old approaches, methods and policies, even though these may have proved highly effective in the past. Increasingly, the need to conceive new development strategies was making itself felt; increasingly it was felt that the key to this development ought lie in revamped scientific, technological, educational and training policies.

The new period is dominated by a movement in favour of endogenous development within the framework of a New International Economic Order still to be established, in favour of a significant restructuring of relations between groups of countries occupying unequal positions in the world economy. In particular, it is characterized by a tendency in favour not only of a strenghtening of the scientific and technical potential of the developing countries as well as their industrial capacities, but also - this is worth stressing- the scientifico-technical transformation of these countries, and the quest for the development and establishment of national educational systems built upon the concept of cultural identity and the qualitative aspects of development.

Development accordingly takes on a multidimensional character in a period charged with upheavals brought about by the scientific and technical revolution, on the one hand; by the ever-faster internationalisation of manufacturing and trade on the other. It is this new situation which conditions the evolution of educational and training systems for the future.

What are the problems facing these systems in this new period of development? What sort of direction could we impart to the changes that need to be made? And, more generally, what is the rôle of education and training? How can they contribute to endogenous development, and in particular to industrialisation and to the transformation of the scientific and technical potential of developing countries? These are the fundamental questions which countries need to be able to answer before going on to devise new development strategies.

(b) Concepts employed : some definitions

The first requisite, in approaching a new theme or project is to identify and define with proper precision the chief notions employed, in the light of the direction and objectives proposed. This is truer still for the project under discussion, which deals with an interdisciplinary theme, thereby complicating the job of definition, since a given notion may be interpreted differently depending upon the different sectors whose relations are to be studied. In addition, the content of notions is capable of changing, and does change, from one phase of development to the next.

It is not the aim of this study to propose new definitions to swell the already plentiful list of existing definitions. We shall make use either of those to which the international community has given wide currency, or else those actually applied in practice in the countries selected for this study. To be sure, not only does this not rule out, but indeed it requires additional clarification of specific points where necessary.

Let us take the notion of "endogenous development" to begin with.

This concept is used to emphasize the specific character of a type of development occuring under clearly determined historical conditions. This type of development is very different from the classical development process characteristic of a number of now advanced European countries.

In one case - Europe - this could be regarded as a "normal" development. These countries never experienced underdevelopment, a qualitative difference in their development, colonial domination and economic dependence in the present sense of these terms. To be sure, there were differences in their levels of development. For example, 19 century Germany lagged behing England and France, in developmental terms. But this was a quantitative rather than a qualitative backwardness, and did not signify underdevelopment. All three countries were passing through the same phase of development, that of a transition from a subsistence economy to a capitalist market economy.

To sum up, the classical development process occurred in succeeding phases: first, an agrarian revolution, which in a sense prepared the ground for the industrial revolution, which in turn created the material base for the scientific and technical revolution. History "handed" the west sufficient time to allow the process to mature and develop "normally" at each stage.

In another case - the developing countries - this process has been distorted. To begin with, the period of colonial domination which brutally interrupted the course of their historical evolution, and its evil consequences for them, are well known. Next, the qualitative backwardness, in other words, the root of their under-development. It also needs to be pointed out that, contrary to what happened in the developed countries of the west, industrialisation in the Third World was not preceded by an agrarian revolution. Lastly, and this is very important, the specific feature of this industrialisation is that it is taking place in an age of scientific and technical revolution.

In short, the developing countries are obliged to cope simultaneously, all at once with three revolutions - agrarian, industrial and scientific -

to handle often contradictory problems created by these three problems. And this in a state of underdevelopment and economic dependence. This is an unprecedented situation which can only complicate enormously their development process.

Consequently, the essential function of endogenous development is to grapple with under-development and foreign economic domination in such a way as to permit development in harmony with national values (cultural, educational and others) and rooted in the country's own resources.

As an essential instrument of endogenous development, the industrialisation of developing countries also assumes a particular colouring that distinguishes it from the comparable process in the now-developed countries of Europe. It proposes new objectives unknown to the latter.

All these special characteristics significantly alter the place of education and training in the development process in this group of countries. This place, the very essence of education and training, and their historic mission, are conditioned by the type of endogenous development being sought and by the key objective of the developing countries, namely the elimination of their under-development and the creation of a modern society from which foreign domination is absent.

Educational and training systems designed to contribute to endogenous development are expected, for example, to eradicate illiteracy; they tackle problems such as mass education, adult education, lifelong education, the reduction of inequalities, etc. These are new functions, i.e. ones not inherent in the educational and training systems that grew up in the 19th century, during the initial developmental phase of the now advanced countries. The type of development experienced by the latter did not give rise to needs such as these. Moreover, it did not require the establishment of educational and training systems under the currently accepted sense of the term, nor the formulation of national-level policies in this sphere, nor again for the planning of educational development or of the development of training for manpower and highly-qualified specialists. These countries had no need to envisage for their educational and training systems expenditure comparable to the vast amounts spent by the developing countries today. They were spared numerous other problems, such as having to create a national research and development sector, technology transfers, etc., all of which are of crucial importance in the war on underdevelopment.

In regard to the general conception of the study, we shall take as our point of departure the particular characteristics of the historical circumstances of the developing countries. All the problems passed in review have been situated in this context. This approach should enable us to identify on the one hand the specific aspects of the problem and, on the other, those aspects which are of common interest to the different groups of countries.

To assess and maximize the contribution of education and training to endogenous development, we have thought it indispensable to base ourselves on the broadest meaning given to these notions. Our analysis therefore covers formal and informal systems of education and training, and the full spectrum of relations between them and industrial and scientifico-technical progress in the developing countries.

A certain nomber of points need to be made clear, however, in order to give flesh to and delimit the field being analysed.

Although this contribution is the outcome of educational action viewed as a whole, the accent is placed on the training of industrial labour and of highly skilled technical and scientific manpower. Education is also reflected from another angle, however, inasmuch as it is seen as a "qualification", if only potential, of labour integrated into a work situation.

Secondly, we have sought to avoid internal reflection on the educational system. Thus, recent trends in education and training have been compared with social movements among skilled workers. Similarly, we have sought to include in our analysis the question of repercussions on the "social demand for education", as well as problems connected with graduate unemployment.

The same principle of adopting the broadest interpretation has been applied to the group of notions relating to science and technology. We have distinguished three aspects of scientific and technical progress in the developing countries :

- scientific and technical potential
- scientific and technical transformation
- transfers of foreign technologies.

Concerning scientific and technical potential, the traditional definition refers to direct factors only: scientific workers, research establishments and infrastructure, R & D organization and planning, etc. This approach seems too restrictive, and needs to be broadened to include the following indicators: the educational level, and the level of scientific and technical culture of the entire population, which constitutes a vital element of this potential, creating a climate receptive to scientific and technical progress.

Scientific and technical potential is a quantitative aspect, rather, of progress in science and technology. The importance of making provision for this aspect in the developing countries is obvious. This priority objective needs to be supplemented by the notion of scientific and technical transformation, the qualitative aspect, which has also come to be a priority in recent years. For a mere quantitative raising of scientific and technical potential is not enough in itself to ensure modern-type development. What is needed is to introduce changes of a structural order designed to reduce the technological dependence of the developing countries.

This last-named objective also conditions policy regarding transfers of foreign technologies. This involves the imported element in scientific and technical progress, whose consequences for the developing countries are many-sided.

We have assumed that technical and scientific development is integrated:

- with education, and especially into the training of scientific and technical manpower, insofar as this is the necessary condition of any kind of integration, as well as of the application of technologies and innovations.
- with the application of scientific and technical knowledge and technological innovations in work and production. Industry represents a prime, though not exclusive, sphere of activity. Thus the "employment" factor must be taken into account in analysis of the relations between education and industrial-technical development, as this is a field of crucial importance, furnishing us with insight into the evolution of the structures of qualifications, into divergent and/or convergent movements

between qualifications, educational levels and jobs from the standpoint of scientific and technical progress. Additionally, the effective deployment of qualifications constitutes an important means of assessing and interpreting educational and training policies.

Technical and scientific development needs to be analysed in all its complexity, which encompasses:

- different countries' economic start-out thresholds;
- national industrial policies, and short and medium-term priorities and objectives;
- the multiplicity of decision-making centres, private/public, national/international;
- areas of industrial activity;
- technological choices;
- employment and manpower policies.

Furthermore, no analysis of educational training systems in national contexts can afford to neglect sectorial changes. Leaving aside certain general elements, our understanding of the repercussions of industrial and technical development on education and qualifications is very patchy and fragmentary, as it is not always applicable to every country. In addition, the international interdependence of industrial development makes all analyses at once too all-embracing and more subject to error in regard to the study of national contexts.

(c) The different approaches

One of the main concerns of educational and training planners over the last ten years has been to satisfy manpower requirements. The leading solutions envisaged sought improved adaptation of educational and training systems - of scientific and technical education in particular - to the needs of the economy. This trend went hand in hand with efforts to redirect and restructure these systems, especially at the secondary level.

In fact, most countries adopted more than one policy on educational matters. Indeed, they exhibit a whole array of differentiated, specific policies, the chief aim of which was some degree of flexibility to permit the necessary adjustments. A number of concrete measures and approaches to the problem of industrialization, qualifications and employment overlap each other, with no sharp line of demarcation between them, neither

theoretical nor concrete. This profusion of approaches, sectorial policies and measures specific to market economy countries corresponds, moreover, to the profusion, or fragmentation even, of decision-making centres: various state bodies, business firms, and so on.

However, the absence of an explicitly co-ordinated national industrialisation plan or industrial and manpower policy by no means signals the absence of effective - albeit limited - policies, or adjustments by sector or by level of qualification. Still, in the various existing documents dealing with the theme of training and employment from the standpoint of industrialisation, we may identify the following approaches:

- The "quantitative disequilibrium" approach: the problem of employing skilled labour can only be resolved by expanding the economy's capacity to absorb it.

- The "qualitative disequilibrium" approach: according to this view, there is a surplus of skilled labour, but also considerable shortages due both to inappropriate training and to the supposedly unrealistic expectations and aspirations of individuals. The answer, therefore, lies in shifting the emphasis of education in the light of the jobs being offered, close links with the world of work in all aspects, as witnessed by attempts to "professionalize" secondary and higher education, and by the expansion of out-of-school education.

There are two other approaches, which emphasize education alone. To begin with, there is the approach which advocates restricting entrance to secondary and higher education, and perhaps even raising tuition fees. The underlying idea is that what causes unemployment is the excessive expansion of the higher echelons of the educational system and the ensuing inflation in diplomas.

While accepting the principle of an inflation in diplomas, the second approach emphasizes, on the other hand, the need to change educational models; according to this view, such change can only be brought about by indirect measures. These would in the first place concern incomes policy, a reduction of income disparities being expected, in theory at least, to damp down the social demand for education. Other measures are aimed at recruitment and promotion patterns, which ought no longer to be based on diplomas alone, but rather on professional aptitude tests (which) are already widely used by the multinational companies).

The systematisation of these approaches gives us some insight into the difficulties that arise when we analyse the problem of education, industrialisation and employment. The general hypothesis refers to a very powerful correlation between education and industrialisation when accompanied by technical progress. National policies for technical and scientific education and industrialisation are based thereon.

Concrete problems arise, on the other hand, when analysing the social and economic conditions connected with the institution and implementation of education in an industrial environment. The fragmentations, adjustments and restructurings of industry and manpower complicate study of the whole. Technological innovations are not introduced across-the-board: they are introduced gradually, scattered in specific sectors of activity within a given branch of the economy, or even within individual enterprises. What is more, the same innovation may not necessarily have the same repercussions in different economic and social sectors and, consequently, on education. We need to bear in mind the analytical pitfalls that may exist, although as we shall see in our review of national policies, there are a certain number of general trends.

CHAPTER II - NATIONAL REFORMS, PLANS AND POLICIES

In this chapter, we shall be looking at the main trends and directions in scientific and technical training in the developing countries. Thus reforms have been viewed in the broadest sense of the term.

In the first part of this chapter, we shall identify the general tendencies common to most developing countries, situating them in a broader overall context.

Part two is the outcome of a comparative analysis of educational plans and of scientific and technical plans in a certain number of developing countries.

The third part deals with the development of training for scientists and engineers with a view to industrial development. Special emphasis has been given to the rôle of the enterprise in scientific and technical training, including efforts to strengthen links between the university and the enterprise.

(a) General trends

The developing countries express their political commitment to industrialisation and, at the same time, their commitment to the restructuring and realignment of technical education, at every level.

However, the planned restructurings and realignments of certain streams of training raise a number of problems, especially when we replace these general trends in their overall social, economic and educational setting.

The question of technical education in the broad sense of the term (i.e. embracing technical and vocational education, the training of medium and higher-level technicians as well as managers) needs to be examined in the light of its differential effects. We may thus point to the creation of new streams and, in certain cases, to the establishment of educational structures linked with industrialisation. But the general trend common to most of the developing countries gives pride of place to the training of skilled industrial labour to worker or technician standard. This is true too of short post-secondary technological training courses.

For more than a decade now, we have been witnessing in most industrializing countries the creation and/or reorganization of university-level colleges or institutes of technology, the creation of technical and industrial

training streams inside secondary education, and the creation of bodies and institutions responsible for the training of industrial labour parallel to the formal educational system.

Questions arise concerning the following points:

- the time perspective of these training courses, and their future prospects;
- the internal co-ordination and articulation of the different types of technical and scientific training set up;
- their external co-ordination and articulation with the economy as a whole, and more specifically with the various sectors of industry; it would be interesting to identify the characteristics of enterprises (by branch sector of the economy, size, manpower structure, technologies and manufacturing processes, development prospects, and so on) in the light of which these training courses were devised;
- the repercussions of these training courses on the working population as a whole, not only in the "modern" sector of the economy but also in the so-called "informal" sectors.

As to high-level scientific and technical personnel, two positions co-exist:

(a) that there are enough - or even a "surplus" for certain countries - technical and scientific managers, many of whom are under-employed.

(b) that there are substantial shortages and scarcities of highly-trained personnel, albeit in certain areas only, which is put down to inadequate training.

The question thus arises at another level: what is at issue here is the relation between training and employment. This concerns on the one hand the appropriateness of training to the types of employment likely to be on offer, to the real possibilities of available jobs, and to sectorial differentiations in the labour market on the other.

The adjustment mechanisms affecting the relations between training and employment may be delineated at several levels:

(i) at the level of occupational integration;

(ii) at the level of the place of production;

(iii) at the level of qualifications profiles;

(iv) at the level of qualifications.

(i) The processes of integrating technical and scientific managers into the labour market are by no means unilateral; still less so, apparently, in that these can under no circumstances be reduced to a question or economic or technical factors alone.

Further, in market economy countries, it is the enterprises which are predominant in determining personnel selection criteria, and this concerns scientific and technical personnel as well, although the criteria are not necessarily technical or scientific themselves. So-called "extrafunctional" qualifications play a large part in shaping these selection criteria.

(ii) A characteristic commonly found in many countries is the predominance of state institutions as the principal employers of highly-trained scientific personnel. The mechanisms, both social, economic and political, underlying national labour market structures remain poorly understood, however. One only comes across very patchy, fragmentary even, pointers to the actual workings of the labour market and, specifically, the manner in which scientific and technical personnel is integrated into occupational life according to the place of production, namely:

<u>private sector</u>:

in large corporations

- national
- multinational in small and medium-sized national businesses.

<u>public sector</u>

in the state machinery, i.e. public and semi-public institutions.

(iii) It is also necessary to examine differences in <u>occupational profile</u> required for the same population, namely scientists, engineers and highly-skilled technicians, in different sectors. The qualifications required, the use made of technological capabilities and "know-how", opportunities for retraining, promotion and further training, relations vis-à-vis technological innovations ... all these can be highly important differentiating factors.

(iv) The question of the "<u>technologies</u>" employed needs to be integrated into this classification: state-of-the-art technologies in the big capital intensive firms, with their up-to-date manufacturing processes; relatively obsolete technologies in the case of small and medium-sized businesses. Regarding state institutions, we need to be able to differentiate between

state corporations (and their technological level) and government agencies employing scientific and technical personnel, though not directly productive, or again research units, whether basic or applied.

(b) Educational, industrial and technological plans: comparative analysis[1]

With the exception of certain Latin American and Asian countries, the education and institutional training provided by most developing countries is insufficient to satisfy the industrial and technical development needs laid down in their National Development Plans.

A complex body of causes lies at the root of this situation, although this by no means rules out the following general hypothesis (which has been widely echoed by a number of official bodies): the absence or ineffectualness of concerted action by the industrial production sectors and the educational institutions is one of the basic causes of the discrepancy between needs on the one hand, and on the other the quantity and the quality of human resources available.

This situation is especially serious when one considers that, for most developing countries, industrialisation is a prerequisite of development, pre-supposing a technological transformation, whether exogenous or endogenous.

Comparison of several experiences studied, however, points to a general clarification of the need for human resources capable of responding to the demands of expanding industrialisation. These stipulations are contained in all the general objectives put forward as priorities in National Plans, announcing the necessity of matching the content and the type of education to the needs of the country.

Concerning concrete policies or educational reforms, these objectives are stressed once again, notwithstanding the absence of concrete measures to achieve the stated goals.

Evaluations of the application of succeeding National Plans reflect the existence of problems obstructing the achievement and effective application of objectives. The principal problem identified is that of a basic inefficiency in the application of reforms; this is reiterated on numerous occasions in the different reports evaluating National Plans.

This gulf between projects as conceived and their application crops up with remarkable frequency.

(1) This part is based on the document prepared by Miss A. Pessis.

In general, the National Plans contain proposals for improving the technical training of manpower, both vocational (skilled worker standard) and in the fields of research and higher education. Particular stress is laid on the concern to improve the material conditions of technical education, along with promotion and further training for the teaching profession. Very frequent emphasis is also placed on the need to reduce the existing gap between the training given to students in technical training establishments at all levels, which is considered too theoretical, and the practice required to enable them to integrate "effectively" with industrial production structure.

In spite of this general tendency to direct education towards practical and concrete aspects, which is regarded as more closely meeting the needs of industrial production, this basic orientation is not translated into concerted action. Analysis of various plans relating both to education and to industry, science and technology reveals a fragmented, diversified manpower situation.

In most industrial plans, human resources are regarded as basic input, apparently presenting no obstacle to the implementation of a policy industrialisation. Practically no reference is made to the qualifications of this manpower or to its training opportunities, other than from the standpoint of jobs. One does, on the other hand, find many references to the problems of technological innovation, although unaccompanied by alternative solutions regarding manpower qualifications or to the problems of employment and unemployment.

Apparently, the problem of training the manpower needed for the implementation of industrial development schemes is the exclusive responsibility of the Education Ministries, which spot lights the lack of consultation and co-ordination between educational and industrialisation plans.

In the field of scientific and technical research, the relation with industry is made much clearer, which is reflected in close links between research and industrialisation policies. This link, however, although presumed in National Plans, is never translated into strategies for action relating to the desired training for future researchers or even into genuine job opportunities. There are some exceptions, though, in countries such as Mexico or Brazil, whose scientific and

technical development plans do manage to contain some strategies for the preparation of the human resources required by industry.

India represents a special case in this respect, in that although it has a very high standard of scientific and technical research (it has the third largest pool of scientific and technical manpower in the world), its human resources are ill-adapted to industrial production conditions, which indicates that the problem of the employment of highly trained manpower is far from negligible.

References to shortages of middle-rank personnel are relatively frequent in most official documents, on the other hand. This observation crops up in plan after plan, in spite of countries' efforts to develop intermediate standard technical training. Factors connected with the "social demand" for higher education would appear to play a considerable part in this.

In the educational plan, training problems are linked - formally at least - to those associated with industrial requirements, and this co-operation is sought at all levels of decision-making. In a good many countries, encouragement is given to close links between training and work in such a way as to shake technical training around the concrete problems of industry. Nevertheless, lack of co-ordination and consultation between the different sectors of industry and the state makes it difficult to implement these projects on a broad scale.

It seems, therefore, that the lack of effective short and medium-term manpower planning leads to fragmentation, or polarization even; we shall be coming back to this fragmentation on frequent occasions in the course of this paper: for in spite of the efforts made by different countries in the field of scientific and technical training, it prevents us from formulating an overall diagnosis and from devising alternative solutions valid for all countries.

The national reports are inadequate, reflecting neither the specific problems of individual sectors nor the obstacles standing in the way of effective implementation of the reforms described. Especially in view of the fact that in most countries training activities are not the exclusive preserve of the state but are also conducted by private firms, which produces still greater fragmentation and diversification.

(c) Scientific and technical skills

Most of the developing countries have placed the greatest emphasis on the development of training for scientists and engineers, alongside that

of medium and higher-level technicians. Their efforts are directed more particularly at the following points:

- the tendency to encourage greater numbers of students to opt for scientific and technical subjects;
- better teaching standards, broadening of subjects, and the institution of a wider range of graduate retraining facilities;
- the trend in favour of closer collaboration between universities and industry, with a view to associating the university with national development goals.

The relative expansion of educational systems and the satisfaction, albeit very partial, of social demand for higher education have resulted in a fairly large increase in the number of higher education students and graduates. But the field that has experienced constant growth in numbers has been the human sciences and the arts.

Unesco statistics give us some figures for the total number of "scientists and engineers", as well as technicians, in a certain number of countries. Although the determining criterion is the level of education, the categories employed are too broad and suffer from the familiar difficulties of international comparability; owing to the often very wide differences between countries, the available data cover situations that are not really comparable in real life.

We possess statistics of graduates showing their precise field of formal scientific qualification for a limited number of countries only. These figures enable us to identify, though only on a global basis, the number of people that have undergone training as engineers or scientists.

In Table 1, using available data, we have recalculated the percentages of humanities, science and engineering graduates. Initial comparison among developing countries shows a high proportion of arts and human science graduates relative to the numbers of scientists and engineers.

However, available figures for the United States, which have been included here for purposes of comparison, shows that the percentage of engineers is not exceptionally high, even though in absolute terms it outnumbers the engineers available to the most of the developing countries.

According to the national studies, in spite of the efforts made, training of technicians and engineers in most developing countries is apparently inadequate. Leaving aside procedures relating to initial

Table 1. Number and percentage of graduates by field of study

Country	Year	Number men/women	% women	Humanities/assimilated Number	%	Science, etc. Number	%	of which Medicine	engineering	Others
Algeria	1977	5 928	-	3 482	58.7	2 446	41.3	18.08	8.5	-
Egypt	1976	59 832	33.8	34 664	57.9	23 699	39.6	10.06	12.2	2.5
United States	1975	1 824 093	44.6	979 391	53.69	317 125	17.38	4.9	3.6	29*
Chile	1977	14 474	51.8	8 777	60.6	5 697	39.4	14.3	10.4	-
Colombia	1975	13 616	-	6 556	48.1	5 192	38.1	11.12	17.28	13.7
	1977	18 780	42.2	12 736	67.8	6 044	32.2	10.7	13.5	-
Venezuela	1976	12 940	-	7 005	54.13	5 586	43.2	12.08	16.7	2.7
Japan	1976	504 638	42.08	357 740	70.8	134 524	26.6	3.6	17.8	2.45
Korea	1977	68 811	32.2	30 567	44.4	34 622	50.3	10.4	19.	5.3
Philippines	1976	137 047	-	106 398	77.6	25 621	18.7	4.8	10.2	3.7
Thailand	1976	22 778	43.5	20 692	74.5	7 086	25.5	9.9	7.7	-

Source: Unesco Annual Statistics, 1979.

* College graduates

training, the main thrust of government policies concerns the improvement and constant promotion of specific training schemes for certain advanced sectors. The qualification and training of engineers does not stop with the granting of a degree, and it seems that the growing demands of industry are raising the problem of co-ordinating and setting up re-training facilities.

These facilities may be financed and organized in many different ways. The most familiar approach, obviously, is that of financing through grants, study travel grants for engineers and scientists to enable them to learn about new production systems. The side-effects of this are too well known, although they depend greatly on the duration and the type of the study or fact-finding travel.

Another form of financing involves state funding of post-graduate training for young engineers. This kind of training ought to be arranged inside the enterprise, with a large measure of practical experience, providing the engineer with an opportunity of putting the skills and know-how learnt at university into practice.

Lastly, there is another approach worth mentioning, which would have the advantage of enhancing the nations's engineering potential, involves the active participation of national engineers in industrial schemes financed and performed by foreign firms. This formula has produced some positive results in a certain number of developing countries, especially in the construction of petrochemical plants. The presupposes that governments negotiate with foreign firms to have their own national engineers play a part in every phase of industrial projects under discussion: this runs counter to the "turnkey" contract, in which the foreign supplier retains exclusive control over the entire project.

Everything depends on the industrialization policy adopted by the country.

(d) The rôle of the enterprise in training

In some developing countries, the private sector is playing a growing rôle in the development of education. This involvement takes two forms, whose respective implications differ greatly: in one case, students and their parents contribute more heavily, while in the other the greater part of the burden is shouldered by the firm.

In spite of correctives introduced by governments, the first form of corporate involvement seems to raise problems of increased inequality among the poorest families. This breeds additional economic and social selection. As to the second form, industry and other productive sectors are unlikely to finance - even partially - general education, but they could contribute to the organization of vocational-type technical training courses if they were then able to employ the labour thus trained.

The Latin American countries have experimented a great deal to date with training taxes and with financial contributions by the productive sector generally, with a view to funding technical and vocational training programmes. In some countries, corporations finance all vocational training (see Table 2) (Brazil, Paraguay, Peru), although the data available dates back to 1974.

These taxes mainly concern initial technical and vocational training. There has been a general tendency for some years, in the countries in this region, to shift the burden of vocational training increasingly onto the private corporations[1]. The poor quality of training in the public system, lack of funds, scarce premises and inadequate facilities, the rapid pace of change in the techniques and technologies employed by firms, the unsuitability for industry's real needs of the manpower thus trained, all help to explain and justify the intensification of links between the enterprise and the vocational training school. The national examples cited most frequently are those of Argentina, Brazil, Cuba and Peru.

The following problems tend to arise in corporate-organized vocational schemes:

- -absence of policy and organization by the firm, which often gives as its excuse lack of motivation on the part of its work force;
- -insufficient backing by management;
- -poor basic education of labour, poor technological background especially;
- -industrial evolution of the firms themselves, which are often obliged to react to technological changes right in the middle of a phase of fierce competition;

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(1) Curso-Taller Lationoamericano sobre Planificación de la Educación Técnica y Profesional de Nivel Medio, Quito, Ecuador, 1975, published in Santiago, Chile, 1976.

Table 2 Latin America: corporate financing of vocational training, 1974 (through tax levels)

Country	Programme	Percentage financed by corporations	No. of enrolments
Argentina	CONET	12	192 731
Bolivia	FOMO	2	662
Brazil	SENAI	100	415 836
	SENAC	100	396 362
Chile	INACAP	3	31 334
Colombia	SENA	99	369 563
Costa Rica	INA	98	9 143
Ecuador	SECAP	47	10 351
Guatemala	INTECAP	60	9 667
Honduras	INFOP	89	4 148
Mexico	ARMO	6	16 871
Paraguay	SNPP	100	2 283
Peru	SENATI	100	21 453
Venezuela	INCE	82	115 251

Source: Inter-American Research Center on Vocational Training (CINTERFOR), Cuadro comparativo y fichas descriptivas de la Instisutiones de Formacion Professional de la America Latina, Montevideo, 1975.

-lack of resources and co-ordination, on the part of public institutions;

-inadequate, or totally non-existent, vocational and pedagogic preparation of instructors and trainers.

Further, it is only the large corporations which organize training courses proper, although small and medium-sized industry accounts for the bulk of industrial firms in the developing countries; this is not a phenomenon specific to the developing countries moreover.

At the same time, it would be hard for the small and medium-sized firms to provide all the training necessary and, consequently, to cover the spectrum of knowledge and know-how required, except perhaps for the type of production specific to the firm at a given moment. So the direct organization of technical training by small firms is not recommended; but this need not rule out other forms of involvement, both technical and financial.

The situation changes when we turn to policies designed to strengthen links between universities and the corporations, from the point of view both of training and of participation in research and development. The scope, the high cost of equipment, even the type of research carried out by companies are a stimulus to greater mobilization and involvement on the part of the universities, to more active participation. University/corporation links may operate on several different levels:

- information and training (exchanges of personnel, alternating practical courses for students, retaining for company personnel, etc.);
- research, through partial or total management of specific projects;
- consultative services provided by the universities;
- popularization and dissemination of current techniques and technologies;
- consultation on improvements to programmes and scientific and technical teaching methods used by the universities.

The actual way in which universities and business organize and co-ordinate their joint activities is of the utmost importance if what is being sought is global development, and not merely the privatization of universities by handing over to particular industrial interests.

Where the training of technical and scientific manpower is concerned, it is nevertheless worth bearing in mind that in the absence of a national project, an over-narrow match between training and the qualifications required by industry at a given moment is liable to produce undesirable long term consequences, owing to the speed at which partial or over-specialized know-how can become obsolete. The risk is greater still unless educational policy emphasizes a sound general education. The risks entailed by a close fit between training and jobs are clearly substantial for the lowest technical qualifications, and indeed for all types of qualification not involving a grounding in basic science and technology. In this case, though, the technological factor - namely the rapid obsolescence of know-how acquired through short on-the-job training - is not the only important one; social factors are involved too, in the sense of growing inequalities resulting from the division of labour.

CHAPTER III - INDUSTRIALIZATION, QUALIFICATIONS AND TRAINING

In the first part of this chapter, we shall attempt to identify some general trends in industrialization, from the point of view of their implications for the training of industrial labour.

In the second part, we shall be discussing changing requirements in connection with qualifications; we shall thereby try to underscore certain underlying trends in regard to their repercussions on industrial manpower as a whole, while at the same time formulating a number of questions.

(a) Differential industrial manpower requirements

No one can deny that the speeding up of industrialization in recent decades has led to a proliferation of demand for scientific and technical skills. But this observation is too general to convey the actual relations of interdependence between industrialization, scientific and technical progress, and differential skilled labour requirements. International studies, moreover, take as their sole basis of comparison the technological thresholds and the structures of qualifications and skills currently operative in the world's most industrialized countries. But this type of comparison is only relevant on the assumption of growing world interdependence, not merely in technology itself, but also in the applications of technology i.e. in the organization of production and work.

The developing countries are therefore faced with a growing number of problems. They are obliged to lay down their industrialization policies well in advance on issues such as:

- type of industrialization, priorities and necessary adjustments;
- the conditons surrounding technology transfers;
- creation and dissemination of new technologies;
- assimilation of foreign and national technologies, and their application on a national scale;
- industrial manpower requirements and combined employment policies.

The creation, dissemination and application of national technologies, even taking a simple transfer as their point of departure, raises specific problems in regard to scientific and technical personnel and to manpower qualifications in general. Integrating the process of technological innovations into the national society is a very important affair, with repercussions on the dissemination of technical qualifications among broad strata of the population.

The choice of technologies is of primordial importance for industrializaing countries, entailing consequences for the organization of work and the job structure, for the degree of integration of the industrial sector with the economy as a whole, and on the types and degrees of scientific and technical skills required.

Accordingly, although it is acknowledged that industrialization implies the transfer of certain advanced technologies, adopting them will undoubtedly pose major problems for the developing countries. These do not stem solely from the fact that these technologies are very much in the possession of the industrial countries, but also from the fact that certain political steps are required for countries to be able to obtain them. Especially because it is the capital goods and manufacturing sectors precisely which play a preponderant rôle in the introduction of advanced technologies into the developing countries. It is these sectors, too, which employ, if not train, the requisite technical and scientific skills.

Generally speaking, the developing countries seem to have opted for fairly different industrialization policies, for one thing; for another, most of them have opted for more than one type of industrialization, applying different rules of development to different branches, often relying on a number of different means of creating new industries.

It seems therefore, in the short term at least, that skilled and highly-skilled manpower requirements are differentiated to some extent, and cannot be reduced to a common denominator. Ot should be pointed out, however, that in the absence of an overall state industrialization and manpower policy, or even one aiming at full employment, skilled manpower requirements are not over-large.

We may look at this <u>diversity</u> of national industrialization policies in the light of three different criteria, with a view to describing the main approaches to the problem of training industrial manpower:

(i) export-oriented industries;

(ii) industries supplying the national market as part of a policy of import substitution and satisfaction of the population's needs;

(iii) sectors or branches of industry having links with the multinational.

(i) In fact, most of the exporting branches[1] to which priority is accorded in national industrialization projects are characterized by the rather

(1) Textiles and clothing, rough processing of metals, shipbuilding, leather and shoes, certain mechanical and electrical tools, etc.

low level of qualifications that they demand and, consequently, by the relative importance of unskilled labour. This assumes that the manufacturing processes and the organization of work employed by national industries will be the same as those in application in corresponding industries in the western world. This is a valid hypothesis inasmuch as these industries seek to achieve international competitiveness. Where labour is concerned, the choice ought to come down on the side of low wages. The qualifications required are likely to have the same structure and contents. But then the level of qualification required for these same branches in the industrial countries too is low.

(ii) This type of approach (the most striking example of which is afforded by South Korea), by no means rules out other manpower and training policies for other sectors or branches of the economy. This happens, for instance in sectors aimed chiefly at import substitution for the national market, hence far more diversified economic activities: often nationally-owned whose prime purpose is to satisfy the needs of the national market, even those this frequently means consumer goods for the middle classes. What, in such cases, would be required in the way of industrial manpower qualifications and what demands would be made, consequently, upon the educational system? There can be no general answer to this: depending on the country, the technical and scientific training of manpower will be determined primarily by national industrialization policies and by the government's ability to co-ordinate and diversify these branches by means of coherent overall policy. In addition, the training of manpower depends as much on the structure of the market as on manpower availability, with all that this concept signifies, e.g. migrations, differentiated unemployment, opportunities of substitution, social and political factors affecting school attendance, etc.

(iii) It looks as though the strategies of the multinational companies are going to become increasingly global in the coming years, and that industrial competition will become increasingly fierce. It should be pointed out, furthermore, that the multinationals, not content with profiting from the international market through their sales, also play a part in structuring the international market.

Those developing countries that are now in a phase of active - though frequently dependent - industrialization are having to cope with several highly complex forms of the industrial power of the developed countries. These forms cannot be reduced,technology alone, in the narrow sense of the

term; they also involve production and marketing strategies, innovations and a capacity for accelerated progress in all types of innovations, personnel management - all these factors need to be taken into account. This is further reinforced by the very structures of industrial power in the developed countries and multinationals specifically, on the one hand, and by the speed at which techniques, technologies and products are changing on the other.

Thus, any developing country's industrialization policy is bound to come up againt firmly-entrenched structures of industrial power as well as problems of technology and know-how.

The existence of customs barriers or other obstacles to the entry of imported goods into developing countries are an incitement to the multinationals to produce some of the wares locally in order to gain easier access to the local market. But what really decides the multinationals to set up production facilities in countries at different levels of development, with their different labour and investment costs, is the comparative labour cost advantage.

The argument frequently used by developing countries to justify the admission of foregin firms is that they create additional jobs. But the skilled work involved in research, general management and administration is concentrated in the country of origin, and all that is left over for the low-wage countries is the unskilled or semi-silled work of mass production; the general management, the production engineers and even the highly-skilled technicians are usually sent out from the country of origin.

For the developing countries, the repercussions of this process on qualifications, if not on the labour market, are tremendous not only for the capabilities and the know-how which the labour force is likely to acquire both immediately and in the longer run. In some cases, this last factor is exacerbated by industrial delocalization.

(b) The problem of qualifications

Analysis of the relations between advanced technology and demands in regard to qualifications raises a whole series of problems as to the definition, measurement and classification of these qualifications. Furthermore, formal education is coming under growing criticism, which is levelled at the systematic over-estimation of formal education and the under-estimation of apprenticeship and on-the-job training which, in the view of certain authors, might well prove more effective.

This return to favour of on-the-job training and apprenticeship at the expense of all forms of schooling needs to be examined in the light of its political impact, as well as from the standpoint of the acquisition of practical skills and know-how.

Does the postulate concerning the possibility of a shortage of qualifications accompanying the introduction of advanced technologies into the developing countries fit the facts? Does this lack refer to the level of qualifications in general, or is it merely sectorial?

Some authors point out that the developing countries do possess highly-skilled labour, and that the problem is not so much one of training and qualifications in general as of "management"-related qualifications. In other workds, the question is whether there really are bottlenecks, or whether these only pose a problem in certain types of qualifications.

Now, to return to our basic problem, in other words the political issue of planning for industrial technology and for the employment of highly trained manager, the question is: can we forecast technological changes on a national or a world scale? To what extent can the developing countries, taken one by one, forecast likely technological changes either within the international corporations or inside the developed countries? And, by way of consequence, to what extent is high-level scientific and technical manpower necessary to the development of advanced technology sectors in the developing countries?

If we think in terms of vocational qualifications in general, stretching all the way from the skilled worker to the engineer, then the question we must answer here is: can we forecast how many qualified people (and at what level) we need to turn out, how much will this cost, and how far in advance of actual requirements? And, a fortiori, which agent - the state, isolated enterprises, trade union officials and representatives of other social bodies - would be capable of defining the contents of these qualifications?

Some authors then go on to formulate the following question: if qualifications arrive on the market in advance of the economy's needs, is there not a risk of side-effects arising from this surplus, for instance migration, a net emigration, or social disturbances attributable to white-collar unemployment?

Indeed, it is essential to analyse the problem in these terms when seeking to define future qualified manpower requirements. There does

however seem to be a certain correlation, although by no means linear. Apart from the problem of nomenclatures and definitions of the structure of qualifications underlying a good many of the ambiguities that bedevil worldwide comparison, one can only examine the match between highly-qualified manpower and advanced technology, in our view, by permanent comparison with the prevailing division of labour, national and international, and by sector-by-sector analysis of the different branches of the economy classified according to criteria of technicality (levels of research and qualifications), capital and labour.

There seems to be no absolute technological determinism regarding the structure of jobs within enterprises. The various dimensions of qualifications - both functional and extra-functional - would appear to act as differentiators, depending on the type and status of the enterprise. In addition, they would appear to have different connotations depending on the place that the individual occupies in the division of labour. Further, skilled and highly-skilled manpower requirements are apparently multi-faceted, and are dictated by other factors in addition to the technical processes employed in production.

Another aspect demands scrutiny: is there such a thing as national specificities where qualifications profiles are concerned, and if so how can we systematize them? Do the multinationals diffuse certain standard, relatively stable model manager profiles? And supposing these differences really were determinant, how could we perceive them? Prevailing recruitment patterns would appear to provide relatively pertinent indicators, although they cannot be dissociated from both the company's and the branch's employment policies.

By way of example, comparisons among developed countries show that the number of senior managers and engineers employed in a given branch of industry, all other things being equal, can vary substantially from one country to another. This would seem to confirm the view that a given technological level may very well correspond to different structures of employment and qualfication.

Studies of recruitment patterns refer openly to a range of extra-functional qualifications, which may vary considerably from country to country, between industrial branches and sectors moreover, as well as according to individual companies' employment policies and, needless to say, to their assigned place within the division of labour.

While the "functional" dimensions of qualifications can be translated into diplomas, into various types and levels of training to be acquired, and into knowledge and know-how, in other words into cognitive factors, "extra-functional" dimensions, on the other hand, are very difficult to circumscribe, especially in view of their ideological aspects.

It would be a mistake to play down the importance of the functional dimensions of qualifications, and more specifically their cognitive dimensions. The possession of certain kinds of know-how and technical or scientific skills guaranteed by diplomas furnish the enterprise with an important indicator, inasmuch as this refers to the selection carried out beforehand by the school system and to a certain socially recognized guarantee of the knowledge actually acquired.

It is in this respect, moreover, that the strict separation between functional and extra-functional qualifications is open to criticism. Although in certain respects this separation may be operational, it distracts attention from the fact that the learning of know-how, technical skills, and indeed knowledge in general, comprises a whole complex of non-cognitive aspects, including attitudes, qualities and types of behaviour, all of which are difficult to quantify . Acknowledgement of the fact that extra-functional dimensions come into play in the recruitment process ought not to lead to a denial of the paramount rôle of the cognitive dimensions of qualifications.

In 1967, J. Vaizey formulated three questions on the subject of relations between industrialization/qualifications and technologies:

- "What is the degree of complementarity between educational development, technological progress and innovations introduced into industry?"
- "What are the qualifications called for by advanced technologies, and how can we measure and classify them?"
- "What part does the manufacturing sector play in introducing advanced technologies into the developing countries?" (1)

These questions are still valid today, even though posed with reference to an outside economic rationale and restricted to the private sector. No mention whatever is made of the social impact of qualifications and their evolution, of structural "distortions" between the supply and demand of highly-qualified labour; of graduate unemployment; or of the (frequently a posteriori) adjustments made by the state machinery.

(1) United Nations, Planning for Advanced Skills and Technologies, New York, 1969.

By way of example, we would refer to the study of Latin America conducted by the CEPAL, and to the problems raised by the case study of Spain.

The CEPAL mentions the following phenomena (1):

(i) Employers are demanding more and more in the way of diplomas and formal qualifications even for clerical and manual jobs. This process is accompanied by changes in the nomenclature and formal conditions demanded of job-seekers. This is producing a shift in the nomenclatures of qualifications - which is reflected in different countries' national statistics: workers are being classified as "employees" or "technicians"; junior managers are called "senior managers".

(ii) Educational supply creates its own demand through the expansion of employment within the educational system itself; through legislation that engenders additional requirements in the way of qualifications; or alternatively through the "distorted absorption" produced by public and private bureaucracies.

(iii) The speed at which the number of secondary and higher education establishments is growing, and concomitantly the number of students, is creating wide differences as to the "quality" and prestige of the diplomas granted. Even so, the criteria according to which it is alleged there are differences in quality need to be demonstrated. So employers thus show a tendency to prefer graduates from a handful of élite establishments, many of them private.

(iv) The most sought-after scientific and technical personnel for industrial and general development tend to be very highly paid, receiving salaries comparable to those paid in the industrial countries. Wage differentials thus tend to widen inside a given country; furthermore, there is said to be a very substantial migration of scientific and technical personnel towards the industrial centres in the region, or outside it, where they can hope for higher incomes and opportunities of further training and professional advancement.

(v) Concomitantly, there is the problem of political and social conflicts generated by precisely these sections of the population, which have received higher education, although in very different ways depending on the national context.

In the same vein, the Spanish case study urgently stresses the principal problems that occur in connection with relations between post-secondary education and production:

(2) CEPAL, Desarrollo y Cambio Social en América Latina, Cuadernos CEPAL, 1977, No.16.

- inability to absorb new graduates;
- unsuitability of training received to the qualifications required by industry;
- the recent tendency to replace graduates with employees trained by the company itself, many of them with "in-house" diplomas; this phenomenon has gained considerable ground, especially in foreign firms;
- substitutions among graduates in certain subjects, such as civil engineering, computer sciences, biology, and certain new professions in the services sector.

Indeed we are now witnessing several different trends and realignments which may appear divergent at first sight:

- The demand for flexibility and greater diversification in the technological capabilities of the labour force, which in practice often comes down to the effective flexibility of labour.
- Greater stress on all-round technical training for easier, more efficient adaptability to future technological changes, but also more closely tailored to the practices of individual firms.
- Different (or even divergent) proposals for solutions and action depending on the "level" of technological and technical training in question: advanced training is due for modernization and improvement where acquisition of the most advanced technology and science is concerned; technical training for "executant" categories is supposed to fit in with the short-term technological demands and conditions stipulated by individual industries for precise tasks.
- Apparently at least, there are very many aspects to the lack of skilled manpower correlative to the type of industrialization occurring in a given country, to employment policies (which are often implicit), to migrations and to secondary phenomena generated by social structures.

Mention should also be made of the frequent allusions to the absence of an "environment" favourable to development of positive capacities, aptitudes and behaviour towards technology and industrial development in the developing countries. Is this meant to refer to lack of a fundamental technological potential (as is the case in most of the agricultural countries in the Third World)? Or does it refer merely to negative attitudes and behaviour towards a certain dependent type of industrialization which has shown itself to be profoundly destructing?

CONCLUSION

Throughout this paper, we have stressed the complexity of the problems and of the solutions to them, the diversity of factors and levels, as well as the profusion of mechanisms and adjustments involved when one tries to analyse the relations between education and industrial and technical development.

These are social, historically determined relations, which can thus only very partially and crudely be subjected to the logic of economic measurement and qualification. At the same time, "education" and "industrial and technical development" are mediated by a series of social phenomena, the most important among them being employment; these phenomena are relatively autonomous, making the task of overall analysis all the more difficult.

In spite of this complexity, the determining factors would appear to be political. It is through their commitment and the cogency of their policies that countries will succeed in devising and implementing adequate, all-embracing strategies and measures to harmonize educational systems with the other factors of endogenous development.

The business of harmonization is a far from easy one, raising problems that are awkward to solve, especially so because the relation between education and development acts as a focal point for a whole host of contradicitions:

- contradicitions due to the fact that the different components of the science/education/technical progress/production sequence are constantly out of phase with each other;
- contradictions - which are inherent in most developing countries owing to social, economic and educational destructuring - brought about by their dependent position;
- contradictions relating to the specificities (for the developing countries) of the technology transfer process.

In order to deal effectively with these contradictions, i.e., to gain control over the transfer of foreign technologies and to steer industrial and scientifico-technical transformation, countries will have to mobilize all their potential, by means of well thought out policies. This implies identifying the lines of interdependence between the different

factors of endogenous development in order to identify the priorities and measures upon which national efforts ought to be concentrated.

But these efforts should be two-sided, not confined to just one of the "parties" concerned.

- from the point of view of education and training, a bolder, more open approach to increasingly rapid scientifico-technical change; constant efforts to raise their level of development; special emphasis on qualitative aspects of their expansion, especially through the introduction and establishment of the polytechnic principle at all levels of the educational system;
- from the point of view of science and technology, the main emphasis should go to transforming the scientific and technical potential (qualitative aspect), not forgetting the need for continued efforts aimed at quantitative expansion;
- from the point of view of technology transfers, action to contribute to the objectives of strategies for endogenous development;
- from the point of view of industry, structural transformation to eliminate domination by foreign firms, multinationals especially, and to play an active and equal rôle in the international division of labour.